FRUIT QUALITY OF "D'ANJOU" PEARS AFTER BIN STORAGE AND LATE-SEASON PACKING

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ABSTRACT

Scald and decay control are problems associated with the long-term storage of "D'Anjou" pears. In this 3-year study, D'Anjou pears were treated with combinations of fungicides (Scholar [fludioxinil], Penbotec [pyrimethanil] and Mertect [thiabendazole]), and antiscald agents (ethoxyquin [ETH] and diphenylamine [DPA]). Little decay was evident with or without the use of fungicides, but scald was a major problem after long-term bin storage. ETH reduced scald incidence, but stimulated the severity of phytotoxicity. However, when fruits were evaluated by quality control personnel, phytotoxicity did not represent a major issue. ETH treatment enhanced sensory scores for finish and pedicel condition, improving fruit grade. In this study, scald control was better with ETH than DPH. However, DPH did produce acceptable scald control even though it aggravated phytotoxicity. D'Anjou pears packed in boxes with ETH and Cu paper wraps developed less decay and scald than pears in polyethylene bags.

INTRODUCTION

"D'Anjou" pears (*Pyrus communis* L.) are normally graded and packed into standard boxes (13.2 kg) before being placed in long-term controlled-atmosphere (CA) storage. If pears require repacking after storage, substantially higher packing and handling costs, as much as $4.60 per box ($2.60

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for the discarded box and the new box plus $2.00 repacking costs), may be incurred. If pears could be successfully stored in bins and packed on demand, the risk of much higher packing costs could be eliminated. CA storage of D'Anjou pears as loose fruit in bins is not common. When D'Anjou pears are stored for long periods in bins, quality problems (scald, scuffing and/or decay) can be aggravated (Kupferman and Gutzwiler 2003). To facilitate long-term storage in bins, these problems must be minimized.

Scald and decay are the major problems associated with the long-term storage of D'Anjou pears. Scald is a physiological problem associated with growing conditions (Smock 1953; Lau 1993), harvest maturity (Lau 1993), fruit size, length of storage (Hardenburg and Anderson 1965), storage conditions (Hansen and Mellenthin 1967; Errampalli 2004) and other factors. Control of scald in pears is achieved with ethoxyquin (ETH), which is generally applied in the form of a drench at various concentrations (Hansen and Mellenthin 1967; Chen *et al*. 1990a,b; Lau 1993) and has been suggested for control of scald in bin-stored fruit (Kupferman and Gutzwiler 2003; Mielke and Drake 2004). Diphenylamine (DPA) can also control scald in pears (Drake *et al*. 2001; Kupferman and Gutzwiler 2003), but it is not registered for use on pears at present.

The two most important postharvest storage decays of pear fruit are gray and blue molds, caused by *Botrytis cinerea* Pers. and *Penicillium expansum* Link, respectively (Pierson *et al*. 1971; Rosenberger 1990; Spotts and Cervantes 2001). Both fungi colonize litter on the orchard floor (Domsch *et al*. 1980), and their airborne asexual spores can contaminate the surfaces of fruits and bins during harvest (Jarvis 1980; Spotts and Cervantes 1994; Sanderson and Spotts 1995). Infection of fruit occurs when spores enter wounds or infect through the abscission zone of the pedicel (Chen *et al*. 1981). Important control measures for these diseases include sanitation, minimizing wounds during harvest and handling and application of fungicides before or after harvest (Rosenberger 1990). Although ETH is used for scald control, it has some fungicidal activity as well (Jarvis 1980).

The standard recommendation for long-term CA storage of prepacked D'Anjou pears in the state of Washington is 1.0–2.0% O_2 and $<$1.0% CO_2 at −1 to −0.5°C (Meheriuk 1993; Richardson and Gerasopoulos 1994). Atmospheres of 2.0–2.5% O_2 and $<$1% CO_2 at −1°C have also been recommended for CA storage of D'Anjou pears (Hansen and Mellenthin 1979; Hardenburg *et al*. 1986; Richardson and Gerasopoulos 1994). Using 2% or less O_2 for long-term CA storage of pears reduced losses of firmness, acidity, greenness and scald severity (Mellenthin *et al*. 1980; Chen *et al*. 1981). Using 3% CO_2 for long-term CA storage of bin-stored pears can also help retain fruit quality (Drake and Elfving 2004).

The research reported here was conducted to determine if D'Anjou pears could be successfully stored in bins and packed late in the season (February/March) while maintaining satisfactory quality with good scald and decay control.

MATERIALS AND METHODS

This study was conducted over three crop seasons using the following fungicides: fludioxinil (Scholar [SCH]), pyrimethanil (Penbotec [PBT]) and thiabendazole (TBZ [Mertect]), and scald inhibitors (ETH and DPA) alone or in combination as prestorage drench treatments to control decay and scald development during storage. During the first year, fruit was obtained from commercial packing facilities the day after harvest (late September). Four bins of CA quality D'Anjou pears were obtained from each of four growers (reps), for a total of 16 bins of fruit. The fruits were divided into four treatments of four bins each (water control, ETH at 1700 ppm, SCH at 300 ppm, ETH at 1700 ppm + SCH at 300 ppm). Drenching treatments (water control, ETH [Decco Inc., Monrovia, CA], SCH [Syngenta Crop Protection, Greensboro, NC] and ETH + SCH) were applied to each bin using the commercial drench facilities located at Stemilt Inc., Wenatchee, WA. After drenching, four bins of each treatment were placed in CA storage rooms. After 2 days of chilling (1°C), the CA atmospheres were established (1.0% O_2 and $<$1.0% CO_2 at 0°C). In late February, all fruit from each treatment was removed from CA storage, transported to a commercial packing facility and packed in either standard pear boxes with paper wrap (3% Cu and ETH) and a polyethylene liner, or into 2.2-kg polyethylene bags with no additional treatment. After packing, the pears were placed in regular-atmosphere (RA) storage for 30, 60 or 90 days to simulate handling and marketing time. After each storage period, two boxes or two bags were evaluated for fruit quality, and two boxes of each treatment and replication were evaluated for incidence of decay and scald development. The fruits were evaluated immediately after removal from storage and again after 7-days ripening at ambient temperature.

In the second year, five bins of CA quality D'Anjou pears were obtained from each of four different growers, for a total of 20 bins. The fruit were divided into five treatments of four bins each (water control, ETH at 1700 ppm + TBZ at 500 ppm, DPA at 1000 ppm + PBT, DPA at 2000 ppm + PBT, DPA at 3000 ppm + PBT). Water, ETH, TBZ, DPA and PBT (Pace International, Seattle, WA) were applied as a drench, and in all instances, PBT was applied at 1000 ppm. After treatment, the fruits were stored in CA rooms as previously described. After CA storage (late February), four boxes of loose-packed pears from each treatment and replication were placed in RA

storage for 30 or 60 days. After each RA storage period, one box of each treatment and replication was evaluated for quality, and another box was evaluated for disorders (scald and decay).

In the third year, 10 bins of CA quality pears were obtained from each of four different growers, for a total of 40 bins. The fruits were divided into nine treatments (control, TBZ at 500 ppm, SCH at 300 ppm, PBT at 500 ppm, TBZ + ETH, SCH + ETH, PBT + ETH; TBZ + DPA, SCH + DPA and PBT + DPA). In all instances, ETH and DPA were applied at 1350 and 1000 ppm, respectively. After chemical treatment, the CA storage procedures previously outlined were followed. After CA storage (late February), one box of loose-packed pears from each treatment and replication was placed in RA storage for 30 days. After RA storage, the fruits were evaluated for quality, disorders (scald) and decay.

Quality factors evaluated were flesh firmness, external and internal color, soluble solids concentration (SSC), titratable acidity (TA), finish (appearance) and visual disorders (scald, shrivel, pedicel [stem] condition, internal breakdown, scuffing and rot). Flesh firmness was determined using the TA-XT2 texture analyzer (Texture Technologies, Scarsdale, NY) equipped with a 7.7-mm probe. External and internal color was determined with The Color Machine (Pacific Scientific, Silver Springs, MD) using the Hunter L^*, a^*, b^* system and calculated hue angle values (Hunter and Harold 1987). SSC and TA were determined from a composite of juice expressed from longitudinal slices from each of 20 fruits.

An Abbé-type refractometer with a sucrose scale calibrated at 20°C was used to determine SSC. TA was measured with a Radiometer titrator (model TTT85; Radiometer, Copenhagen, Denmark). Acids were titrated to pH 8.2 with 0.1-N NaOH and expressed as percent malic acid. Finish and visual disorders (scald, burn, shrivel, dark skin disorder and stem condition of samples) were determined by pear industry quality control individuals (15) familiar with winter pear disorders rating each fruit on a scale of 1 to 4 (1 = none, 4 = severe). Scald and rot were also determined by laboratory personnel on the additional fruit (~40) in each box and rated as either present or absent, and reported as percent. Data were analyzed using MSTAT-C (version 1.0, Michigan State Univ., East Lansing, MI, 1988). Separation of means was carried out by analysis of variance on single degree-of-freedom comparisons or by using Tukey's honestly significant difference test following a significant F-test ($P \leq .05$).

RESULTS AND DISCUSSION

Prestorage drench treatments (fungicides and scald inhibitors) on pears in bins had little influence on the peel color and firmness of pears packed in

TABLE 1.
QUALITY ATTRIBUTES OF "D'ANJOU" PEARS AFTER PRESTORAGE DRENCH, CONTROLLED-ATMOSPHERE STORAGE IN BINS (120 DAYS), THEN REGULAR-ATMOSPHERE STORAGE IN EITHER PACKED BOXES OR POLY BAGS FOLLOWED BY 0 OR 7 DAYS RIPENING

	Packed boxes			Poly bags		
	Peel color		Firm	Peel color		Firmness
	L	Hue (°)	(*N*)	*L*	Hue (°)	(*N*)
Drench treatment						
Control†	58.9a*	97.1a	23.6a	58.8a	97.9a	25.6a
ETH‡	59.5a	96.4ab	21.8a	60.2a	96.9a	22.9a
SCH§	58.9a	96.8a	23.6a	58.7a	97.1a	24.7a
ETH + SCH¶	58.9a	95.5b	22.0a	59.5a	96.5a	24.2a
Storage time (days)						
30	58.0b	98.0a	27.2a	58.2b	98.9a	27.7a
60	59.5a	96.2b	20.9b	–	–	–
90	59.7a	95.2c	20.0b	60.4a	95.8b	21.0b
Ripe (days)						
0	55.9b	100.4a	38.2a	56.5b	101.4a	41.3a
7	62.2a	92.4b	7.2b	62.1a	92.9b	7.5b

* Mean values in a column not followed by a common letter are significantly different by Tukey's honestly significant difference ($P \leq 0.05$).
† Water drench only.
‡ ETH drench at 1700 ppm.
§ SCH drench at 300 ppm.
¶ Combination drench of ETH + SCH.
ETH, ethoxyquin; SCH, Scholar.

boxes, and had no effect on pears in poly bags (Table 1). Using ETH + SCH reduced the green color (hue) in packed pears. This color difference for pears treated with ETH + SCH was greater than one color unit when compared with control fruit and fruit treated with SCH alone, and would be visible to the consumer (Hunter and Harold 1987). Treating pears with ETH alone resulted in no significant color loss. Color and firmness of pears packed in poly bags after bin storage were not affected by drench treatment.

After bin storage in CA, longer RA storage time resulted in lighter color (higher *L* values), loss of green color (hue) and firmness for both pears in packed boxes and poly bags, regardless of bin treatment (Table 1). This change in color and loss of firmness for packed pears was very pronounced between 30 and 60 days of storage and less so after 90 days of storage. Color and firmness values were similar between pears in packed boxes versus poly bags after 90 days of storage. Pears ripened for 7 days lost color and firmness to a similar degree in both packed boxes and poly bags. Pears in packed boxes or poly bags were at an excellent firmness level for eating ($<$7.5 N or less) after 7 days.

TABLE 2.
DECAY AND SCALD INCIDENCE OF "D'ANJOU" PEARS AFTER PRESTORAGE DRENCH, CONTROLLED-ATMOSPHERE STORAGE IN BINS (120 DAYS), THEN REGULAR-ATMOSPHERE STORAGE IN EITHER PACKED BOXES OR POLY BAGS FOLLOWED BY 0 OR 7-DAYS RIPENING*

Drench treatment	Ripe (Days)	Packed boxes		Poly bags	
		Decay (%)	Scald (%)	Decay (%)	Scald (%)
Control†	0	<1.0b	<1.0c	2.5b	5.0b
	7	5.4a	8.8a	8.1a	31.3a
ETH‡	0	<1.0b	<1.0c	<1.0b	<1.0c
	7	4.2a	2.9bc	1.3b	6.9b
SCH§	0	<1.0b	<1.0c	<1.0b	<1.0c
	7	<1.0b	3.8b	1.3b	35.0a
ETH + SCH¶	0	<1.0b	<1.0c	<1.0b	<1.0c
	7	<1.0b	2.1bc	1.3b	<1.0c

$n = 80$ to 100.
* Mean values in a column not followed by a common letter are significantly different by Tukey's honestly significant difference ($P \leq 0.05$).
† Water drench only.
‡ ETH drench at 1700 ppm.
§ SCH drench at 300 ppm.
¶ Combination drench of ETH + SCH.
ETH, ethoxyquin; SCH, Scholar.

The amount of decay and scald present on pears after storage was dependent upon drench treatment and ripening time (Table 2). Using SCH or SCH + ETH virtually eliminated decay in boxed or poly-bagged pears. Without SCH, boxed pears treated with ETH displayed as much decay as control pears. Pears in poly bags treated with ETH displayed little or no decay. Earlier research (Usall *et al*. 2001) indicated that ETH may have fungicidal activity. Scald was evident after ripening in both boxed and bagged pears not treated with ETH. ETH inhibited but did not necessarily eliminate scald in both boxed pears and pears in poly bags. SCH + ETH completely eliminated scald for bagged pears; scald was not completely eliminated in bagged pears (6.9%) when ETH was applied alone.

Industrial quality ratings for scald and burn showed no treatment effects, but ratings for fruit appearance, finish and pedicel condition did differ among treatments (Table 3). Quality rating scores that were more than 2.0 were not considered acceptable. SCH-treated fruit showed poorer appearance and finish than control fruit, while ETH-treated fruits were equivalent in appearance and finish to controls. Fruits treated with the combination of SCH and ETH were equivalent in appearance and finish to ETH-only fruits.

Pedicel condition was best in pears treated with ETH, or ETH + SCH. In control pears, pedicel condition was scored as marginal (2.1). Subjective

TABLE 3.
SUBJECTIVE EVALUATION OF "D'ANJOU" PEAR EXTERNAL FRUIT CONDITION BY INDUSTRIAL PERSONNEL AFTER PRESTORAGE DRENCH TREATMENT, CONTROLLED-ATMOSPHERE STORAGE IN BINS (120 DAYS) AND SUBSEQUENT REGULAR-ATMOSPHERE STORAGE IN PACKED BOXES FOR 60 DAYS (NO RIPENING)

Drench treatment	Evaluation**				
	Appearance	Finish	Scald	Stem condition	Burn
Control†	2.0b*	1.9b	1.2a	2.1a	1.2a
ETH‡	2.0b	2.0ab	1.3a	1.9b	1.2a
SCH§	2.4a	2.3a	1.3a	2.0ab	1.1a
ETH + SCH¶	2.2ab	2.1ab	1.2a	1.8b	1.1a

$n = 25$.
* Mean values in a column not followed by a common letter are significantly different by Tukey's honestly significant difference ($P \leq 0.05$).
† Water drench only.
‡ ETH drench at 1700 ppm.
§ SCH drench at 300 ppm.
¶ Combination drench of ETH + SCH.
** Evaluated on a scale of 1–4 (1 = excellent, 2 = good, 3 = fair, 4 = poor); $n = 34$.
ETH, ethoxyquin; SCH, Scholar.

scores for scald among treatments showed no differences, as was expected because pears showed no scald immediately after removal from storage (Table 2), and the fruit were rated for scald after only 1 day at ambient temperature.

Only a small amount of decay (<2%) was present even after 210 days of total (bin + box) storage (Table 4). This decay occurred only in nontreated pears and consisted almost entirely of gray mold (*B. cinerea* Pers.). When mold growth was identified by species, all SCH and ETH treatments, alone or in combination, controlled mold growth. This control of mold growth by ETH alone was not evident earlier (90 days), when total decay was determined on these same treatments (Table 2).

During the second year of the study, drench treatments had no influence on objective fruit quality (firmness, color, SSC or TA) of D'Anjou pears (data not shown). Subjective fruit quality was influenced by the addition of scald control agents (ETH and DPA) to the prestorage drench (Table 5). No scald was evident in the fruits immediately after removal from the bin (120-days CA storage) and box (30-days RA storage), but both ETH- and DPA-treated fruit showed phytotoxicity (% and subjective score). Sixty-three percent of D'Anjou pears drenched with ETH displayed light-colored, pink rings. Pears drenched with DPA at 2000 and 3000 ppm also displayed phytotoxicity (14 and 52%, respectively). Pears treated with ETH or DPA at 3000 ppm received

TABLE 4.
DISEASE INCIDENCE IN "D'ANJOU" PEAR FRUIT AFTER PRESTORAGE DRENCH, CONTROLLED-ATMOSPHERE STORAGE IN BINS (120 DAYS) AND SUBSEQUENT REGULAR-ATMOSPHERE STORAGE IN PACKED BOXES (90 DAYS)

Drench treatment	Disease incidence, by species, in D'Anjou pears (%)		
	Total decay	Blue mold	Gray mold
Control†	1.9a*	<1.0a	1.2a
ETH‡	<1.0b	<1.0a	<1.0b
SCH§	<1.0b	<1.0a	<1.0b
ETH + SCH¶	<1.0b	<1.0a	<1.0b

* Mean values in a column not followed by a common letter are significantly different ($P \leq 0.05$). Data were transformed to arcsine square-root values before analysis of variance. Values shown are untransformed means.
† Water drench only.
‡ ETH drench at 1700 ppm.
§ SCH drench at 300 ppm.
¶ Combination drench of ETH + SCH.
ETH, ethoxyquin; SCH, Scholar.

unacceptable (>2.0) subjective evaluation scores. Nontreated pears or pears treated with DPA at 1000 or 2000 ppm received acceptable (<2.0) subjective scores for phytotoxicity. Pedicel condition was rated as unacceptable only for pears treated with DPA at 3000 ppm; pedicel condition was acceptable for all other treatments (control, ETH, DPA at 1000 and 2000 ppm). Scores for fruit finish were unacceptable (>2.0) for control fruit and all treatments except DPA at 1000 or 2000 ppm, respectively. These pears were evaluated shortly after removal from storage.

After 7 days at ambient temperature, control pears and pears treated with DPA at 1000 or 2000 ppm showed significant scald (Table 5), while pears treated with ETH or DPA at 3000 ppm showed less than 5% scald incidence. Pears treated with lesser amounts of DPA (1000 and 2000 ppm) also displayed reduced scald, but not at acceptable levels (27 and 19%, respectively). There was a direct relationship among scald, phytotoxicity and the amount of DPA in the drench treatment. As the amount of scald was reduced, the amount of phytotoxicity was increased. After 7 days at ambient temperature, all subjective scores for pedicel condition and finish were too high and not acceptable.

In the third year, D'Anjou pears stored in bins for 120 days of CA, then in boxes for 30 days of RA and then allowed to ripen at ambient temperature for 4 days displayed scald symptoms regardless of the fungicide used (Table 6). If a scald inhibitor was included in the drench, scald was reduced to acceptable levels, but phytotoxicity was enhanced to excessive levels (30% or more). TBZ + ETH, SCH + ETH and PBT + ETH controlled scald to similar

TABLE 5.
INFLUENCE OF FUNGICIDE (TBZ) AND SCALD INHIBITORS (ETH AND DPA) ON SEVERAL INDICES OF FRUIT FINISH AND EXTERNAL QUALITY OF "D'ANJOU" PEARS AFTER LONG-TERM CONTROLLED-ATMOSPHERE STORAGE (120 DAYS) IN BINS AND SUBSEQUENT STORAGE IN REGULAR ATMOSPHERE (30 DAYS), 2003

Treatments	Scald (%)	Phytotoxicity (%)	Subjective evaluation (1–4)†		
			Phytotoxicity	Stem condition	Finish
Nonripened (0 days)					
Control (water only)	0	0c*	1.0c	1.7c	3.3a
TBZ + ETH‡	0	63a	2.7a	1.9b	2.9a
TBZ + DPA§	0	0	1.0c	1.5d	1.5c
TBZ + DPA¶	0	14b	1.3bc	2.0b	2.3b
TBZ + DPA**	0	52a	2.8a	2.4a	2.9a
Ripened (7 days)					
Check (water only)	63a	0c	1.7d	2.2b	2.4b
TBZ + ETH‡	3d	72a	2.8ab	2.2b	2.4b
TBZ + DPA§	27bc	3c	2.1c	2.3b	2.1b
TBZ + DPA¶	19c	26b	2.5bc	2.1b	2.1b
TBZ + DPA**	5d	67a	2.9a	2.8a	3.1a

* Means in a column within ripening times not followed by a common letter are significantly different by Tukey's honestly significant difference ($P \leq 0.05$).
† Evaluated on a scale of 1–4 (1 = excellent/none, 2 = good/minor, 3 = fair/moderate, 4 = poor/severe).
‡ TBZ at 500 ppm + ETH at 1700 ppm, drench.
§ TBZ at 500 ppm + DPA at 1000 ppm, drench.
¶ TBZ at 500 ppm + DPA at 2000 ppm, drench.
** TBZ at 500 ppm + DPA at 3000 ppm, drench.
ETH, ethoxyquin; DPA, diphenylamine; TBZ, thiabendazole.

levels, but also enhanced phytotoxicity to comparable levels. TBZ + DPA and SCH + DPA controlled scald to a similar extent as to these fungicides combined with ETH. PBT + DPA also controlled scald development, but not to a comparable level. Unfortunately, control of scald with either ETH or DPA led to a major problem with phytotoxicity, which occurred beyond acceptable levels (30%).

When evaluated subjectively, scald was very evident in pears without either ETH or DPA, and scores for scald were all in excess (3.1, 2.6, 3.1) of acceptable levels (>2.0). Scores for phytotoxicity were very acceptable (<2.0) for all combinations of fungicide and scald inhibitor, except SCH in combination with ETH. SCH + ETH resulted in a subjective score of 2.4, which was considered unacceptable in this study. Finish scores were best (1.7) for TBZ + ETH or PBT + DPA. All other scores for finish were in excess of

TABLE 6.
EVALUATION OF EXTERNAL FRUIT FINISH CHARACTERISTICS IN "D'ANJOU" PEARS BY INDUSTRY QUALITY CONTROL PERSONNEL AFTER LONG-TERM CONTROLLED-ATMOSPHERE STORAGE (120 DAYS) IN BINS, SUBSEQUENT STORAGE (30 DAYS) IN REGULAR ATMOSPHERE AND 4 DAYS AT AMBIENT TEMPERATURE, 2004 ($n = 22$)

Fungicide	Scald inhibitor	Scald (%)	Phytotoxicity (%)	Hue (°)	Subjective evaluation (1–4)†			
					Scald	Phytotoxicity	Finish	Stem condition
TBZ‡	Control	35a*	0b	97.3bc	3.1a	1.2c	2.3a	3.1a
	ETH**	3d	41a	97.1bc	1.5c	1.8b	1.7b	1.5c
	DPA††	6d	35a	97.5bc	1.5c	1.4bc	2.3a	1.6c
PBT§	Control	21b	0b	99.4a	2.6b	1.3c	2.3a	2.6b
	ETH**	6d	30ab	95.5d	1.7c	1.3c	2.3a	1.7c
	DPA††	15bc	38a	98.4ab	2.8ab	1.3c	1.7b	2.8b
SCH¶	Control	31a	0b	97.2bc	3.1a	1.4bc	2.3a	3.1a
	ETH**	4d	42a	96.1cd	1.1d	2.4a	2.3a	1.1d
	DPA††	8cd	45a	97.9b	1.1d	1.4bc	2.4a	1.1d

* Means in a column not followed by a common letter are significantly different ($P \leq 0.05$).
† Evaluated on a scale of 1–4 (1 = excellent/none, 2 = good/minor, 3 = fair/moderate, 4 = poor/severe).
‡ TBZ drench at 500 ppm.
§ Penbotec drench at 500 ppm.
¶ SCH drench at 300 ppm.
** ETH at 1350 ppm.
†† DPA at 1000 ppm.
TBZ, thiabendazole; SCH, Scholar; ETH, ethoxyquin; DPA, diphenylamine; PBT, Penbotec.

2.0, regardless of fungicide or scald inhibitor used, and thus were considered as unacceptable. Pedicel condition scores were acceptable when ETH or DPA was used in combination with TBZ or SCH. PBT + DPA resulted in poor pedicel condition, while PBT + ETH resulted in acceptable pedicel scores. Color (hue) was reduced when ETH was combined with PBT and, to some degree, when combined with SCH. Reduced hue would indicate a pear with less green color. This change was in excess of one color unit and would be visible to the human eye (Hunter and Harold 1987). ETH did not produce a similar effect on pear color in the first year of this study.

CONCLUSIONS

Scald and decay control are the major problems associated with the long-term storage of D'Anjou pears. In this 3-year study, decay problems were limited with or without the use of fungicides, but scald control was a major problem after long-term bin storage. Decay only became a problem when the pears were stored without fungicides. ETH reduced scald incidence to acceptable levels but stimulated the severity of phytotoxicity. However, when the fruits were evaluated by quality control personnel, phytotoxicity did not represent a major issue, and the amount of scald present was within reason. In some instances, ETH treatment enhanced scores for finish and pedicel condition, improving fruit grade. In this study, scald control was better for ETH than DPA. DPA is not registered for use on pears at present. However, DPA did produce acceptable scald control even though it aggravated phytotoxicity; DPA might be considered for future use as a scald control for pears. D'Anjou pears packed in boxes with ETH and Cu paper wraps developed less decay and scald than pears in poly bags. If pears are to be packed in poly bags after bin storage, additional means of decay and scald prevention need to be employed.

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